Simplified Mechanical Description of AVE S-103 - ICE3 Velaro E High Speed Train

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Contents

Disclaimer

This information has been compiled from various sources and represents in a simplified and average manner the geometrical and mechanical data for the

AVE S-103 (ICE3 Velaro E) high speed train.

It is completely unofficial and also not exact, but is deemed to represent in an approximate manner the high speed cars similar to those from the AVE S-103 (ICE3 Velaro E) train. For official data either the train manufacturer (Siemens AG) or the railway operator (RENFE) should be approached. The data is provided as is, solely for the use in non-profit mathematical simulations. The use of these data and the results which could be eventually obtained are the sole responsibility of the user. No liability is accepted for any results obtained from the use of these data nor from any possible errors contained.

1 Generalities

The AVE S-103 is a distributed traction, high-speed multiple unit train. It is composed by 8 cars with a total length of 200.32 m. It is also possible to join two units to form a double unit train, with a total length of 400.64 m. Each 8-car unit is symmetric at the middle between the first 4 cars and the remaining 4. Cars C1, C3, C6 and C8 have powered axles, the rest are non-driven axles. A schematic view of one half of the train is described in figure 1. Some views of a motorised bogie may be seen in figure 2.

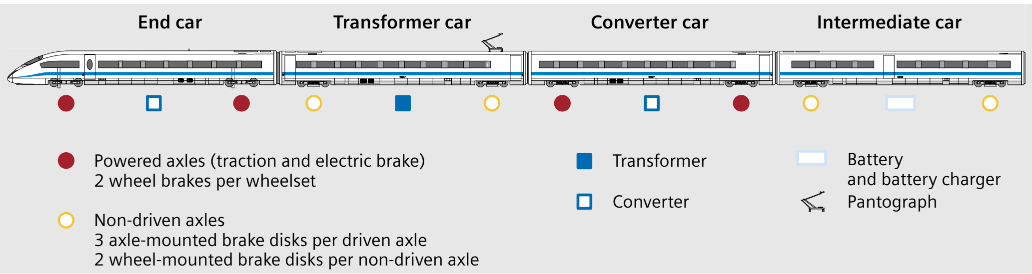

Figure 1: Schematic description of the first 4 cars (symmetric half) of the AVE S-103 including the power and distributed traction system

The maximum speed is 350 km/h, and the trains operate regularly in the Madrid–Barcelona line at 310 km/h. The distance between the two cities is 610 km and the commercial time is 2h 38m, yielding an average speed of 231 km/h. The reported total empty mass is 425 t, the fully loaded mass (*design mass under normal payload*, EN 15663) is considered here to be 480 t.

In what follows the standard conventions will be taken for naming the axes: x is the longitudinal track direction, y the lateral direction, and z the vertical direction.

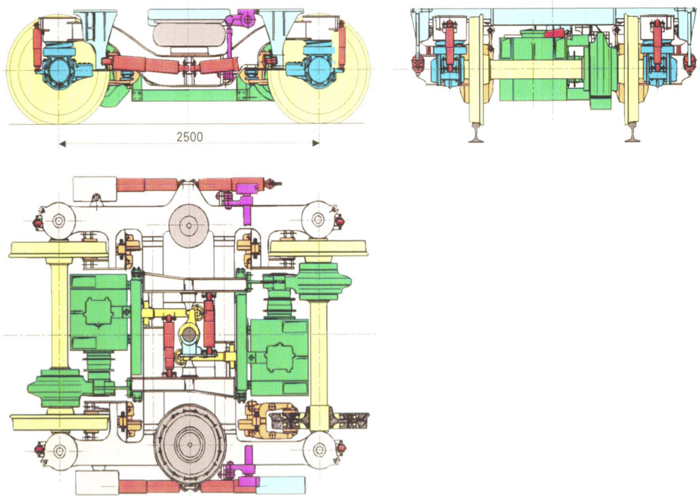

Figure 2: Bogie (motorised) for the AVE S-103

2 Geometry

The terminology employed in the following data $(2a^*, 2a^+, u_1 + u_2$ etc.$)$ is the standard one from rolling stock technical descriptions.

- Distance between bogie centres in one car: $2a^* = 17.375$ m
- Distance between axles in one bogie: $2a^+ = 2.5$ m
- Distance between bogie centres from adjacent cars: $(u_1 + u_2) = 7.4$ m
- Distance from nose to first bogie centre: $u_3 = 4.76$ m
- length of intermediate cars: $L = 24.775$ m
- length of end cars: $L = 25.835$ m

3 Suspension

3.1 Primary suspension

Primary suspensions are located in axle boxes at both sides of each axle, with a separation between centres of 2 m in the lateral (y) direction (figure 2). The following data are simplified approximate values, which may be taken as representative for all the axles. However, actual data may differ between axles. The data are given per axle box, i.e. they must be multiplied by 2 for the complete axle.

$k_{1,z}$ (kN/m)	$c_{1,z}$ (kN m^{-1} s)	$k_{1,x}$ (kN/m)	$c_{1,x}$ (kN m^{-1} s)	$k_{1,y}$ (kN/m)	$c_{1,y}$ (kN m^{-1} s)
1200	10	$12.5 \cdot 10^3$	9	$120 \cdot 10^3$	27.9

3.2 Secondary suspension

The main elements of secondary suspension of vehicle car bodies on the bogies are provided by air springs, of which there are two at the centreline of each bogie, separated 2 m in the lateral (y) direction (figure 2). Again the values may differ between different cars, but here for the sake of simplicity they will be considered uniform for all cars.

$k_{2,z}$ (kN/m)	$c_{2,z}$ (kN m^{-1} s)	$k_{2,x-y}$ (kN/m)	$c_{2,x-y}$ (kN m^{-1} s)
350	20	240	30

Note that other mechanical elements such as bumpstops, torsion bars, pivots connecting bogies and carbodies and anti-yaw dampers are not included here.

4 Masses and Inertias

4.1 Axles

Although not all axles are equal, for simplicity it is proposed to consider the following common values.

m_w (kg)	I_x (kg m^2)	I_y (kg m^2)	I_z (kg m^2)
1800	1000	100	1000

4.2 Bogies

Bogies have different characteristics depending on the car and specific functions and equipment. For simplicity here it is proposed to consider just two types, depending on the car. Bogies for the other cars are to be considered with a symmetric arrangement.

Cars	m_b (kg)	I_x (kg m^2)	I_y (kg m^2)	I_z (kg m^2)
C1–C3	3500	2835	1715	4235
C4	2800	2268	1372	3388

4.3 Car bodies

Car bodies have different characteristics in each case (figure 1). For simplicity here it is proposed to consider just two types, being lighter the central intermediate cars. The other cars are to be considered with a symmetric arrangement.

Cars	m_b (kg)	I_x ($\mathrm{kg\,m^2}$)	I_y ($\mathrm{kg\,m^2}$)	I_z ($\mathrm{kg\,m^2}$)
C1–C3	47800	119328	1957888	1957888
C4	41200	102852	1687552	1687552

5 Axle loads

Considering the geometrical configuration and the mass of each element given above, the following distribution of static masses on each axle is obtained. The distances are of course relative between consecutive axles.

axle	distance (m)	load (t)
1	3.51	15.5
2	2.5	15.5
3	14.875	15.5
4	2.5	15.5
5	4.9	15.5
6	2.5	15.5
7	14.875	15.5
8	2.5	15.5
9	4.9	15.5
10	2.5	15.5
11	14.875	15.5
12	2.5	15.5
13	4.9	13.5
14	2.5	13.5
15	14.875	13.5
16	2.5	13.5

axle	distance (m)	load (t)
17	4.9	13.5
18	2.5	13.5
19	14.875	13.5
20	2.5	13.5
21	4.9	15.5
22	2.5	15.5
23	14.875	15.5
24	2.5	15.5
25	4.9	15.5
26	2.5	15.5
27	14.875	15.5
28	2.5	15.5
29	4.9	15.5
30	2.5	15.5
31	14.875	15.5
32	2.5	15.5
	3.51	
total	200.32	480.00